Chapter 4

Outcomes of the application of the phase plan in the case study

Results from Phase 1

4. RESULTS FROM PHASE 1

4.A1.1 INFORMATION WORKSHOP E-GOVERNMENT AND 4.A1.2 BRIEFING THE WORKFORCE

The author took advantage that In Dar es Salaam different workshops to sensitise decision makers of the importance of e-Governance had already been organised. This started from 1998 with the National ICT roundtable. As an action taken in consequence of those workshops, the personnel of the public administration had been briefed and informed on the needs and advantages of e-Government.

Accordingly, the activity “Information workshop for the senior manager” was transformed in the organisation of one e-Government project kick-off meeting with representatives of UCC and IT managers of all four local authorities. The workshop had been organised in UCC venues on 20th April 2005.

4.A1.3 SELECTION OF AN E-GOVERNMENT TEAM AND 4.A1.5 QUALIFICATION OF THE E-GOVERNMENT TEAM

The e-Government Team has been set up as a result of the kick-off meeting and has been composed of:

- IT Manager of the City Council
- IT Manager of Kinondoni Municipality
- IT Manager of Ilala Municipality
- IT Manager of Temeke Municipality

- Managing Director of University Computing Centre
- The author as ICT Consultant

4.A1.4 SETTING UP THE E-GOVERNMENT PROJECT

As mentioned in the preface, the e-Government project had not officially been approved, so this phase could not be performed by the author. Nevertheless the e-Government team continued its efforts in the limit of its possibilities.

Chapter 5

Results from Phase 2 in the case study

5. RESULTS FROM PHASE 2 IN THE CASE STUDY

5.A2.1 DEFINITION OF E-GOVERNMENT OBJECTIVES FOR THE PUBLIC AGENCY

The e-Government Team identified the objectives for the e-Government project and prioritised as follows:

Priority 1. Rationalisation, increase of efficiency and effectiveness

Priority 2. Increase of transparency

Priority 3. Spread available information to the public (events, procedures, online forms)

5.A2.2 SELECTION AND EXCLUSION OF ONLINE-CAPABLE SERVICES

A very extensive analysis of the informational needs of the departments of the four local authorities has been performed (see Appendix A).

After this step, the e-Government team was requested to decide which service should be implemented as next. For this selection the services which are still need to be implemented in Kinondoni Municipality has been considered. Since this is the local authority in Dar es Salaam with the most advanced status in the e-Government project, it can make other achievements available also for the other local authorities and it would not be useful to implement some services which are already available.

Regarding Kinondoni the identified priorities for needed Information Systems were three:

- Document Management System (DMS)
- Geographic Information System (GIS)
- Education Management Information System (EMIS)

Other considerations like: number of customers affected by this implementation, expected advantages reachable and difficulty of realisation have been weighted. The decision was taken for the Education Management Information System (EMIS). This is also in agreement with the priorities given by the Tanzanian Central Government.

Aim of this research work will be to elaborate an Information System which will serve both the needs of the local level (schools, District ED) as of the regional level (Regional ED) and finally of the central level (MOEC).

According to this decision, the remaining activities of the framework have been applied to the district Education Department (ED), which is the ED at the municipalities.

5.B Stakeholders for the EMIS project

A very important note should be introduced here: until now, the application of the phase plan the meaning of “public agency” has only considered to be the district level (the three municipalities and the City Council). This view is no longer sufficient, since the main stakeholders for the Education Management Information Systems are:

- Schools
- Local Government (Municipalities, District ED)
- Regional ED

- Central Government (MOEC)

When requesting an Education Management IS, the Ministry has given the first priority to the district level. Therefore the research will be extended - in the limit of the possibilities - to consider also the regional and the central government level.

As discussed in 6.A3.6, the different stakeholders have different information needs, different urgency of realisation and require a different technological and financial effort to be realised. The suggestion which the author will expose in detail on the following pages will be a modular introduction of a first EMIS solution for the needs of the ministry, called EMIS1. This solution could later get integrated and extended to the more comprehensive and powerful system EMIS2

5.A2.3 DETERMINATION OF EVALUATION CRITERIA FOR ONLINE-CAPABLE SERVICES

In order to define evaluation criteria for potential online-capable services, the objectives of the District Education Department (ED) as defined above was then subdivided into the sub-goals

Main objective of the District ED:

Rationalisation, increase efficiency and effectiveness

Sub-goals of the District ED:

- Reduction of routine activities
- Information updated, available and easy retrievable
- Automated reports

The e-Government solution will be evaluated according its compliance to the main objective and to the sub-goals

5.A2.4 COLLECTION OF INFORMATION REGARDING ONLINE-CAPABLE SERVICES

This has been done with the following methods:

- Evaluation of the three questionnaires answered by the three Head of the ED in the three municipalities[15]
- Meetings with Kinondoni Municipal Educational Officer[15]
- Meeting with the ICT responsible for education in Kinondoni Municipality[15]
- Meeting with representatives of the statistical team, Kinondoni ED
- Collection of information on Tanzania education system
- Reading of publications of the Ministry of Education and Culture (MOEC)[16171819]
- Interviews with Head of Teachers and teachers from primary and secondary schools[20]

[15] The answers of the questionnaire of the ED of Kinondoni and Temeke are reported in Appendix A

[16] **MOEC** – *EMIS Development Plan 2005 -2008 – Education Sector Development Programme – Information and Communication Technology (ICT).* January 2005

[17] **MOEC***, Education Sector Development Programme, Primary Education Development Plan (PEDP)* 2002 – 2006, April 2004

[18] **MOEC, Basic Education Development Committee (BEDC),** *Education Sector Development Programme, Secondary Education Development Plan (SEDP) 2004 – 2009*, July 2001

[19] **MOEC,** *Basic Statistics in Education,* 2003

[20] The names and professional positions of the interviewees is reported in the chapter "List of Interviewee"

5.C Assessment of information need – Education Department, Ilala

Table 10: Assessment of information need - Education Department, Ilala

Department	Education Dept.	Ilala
Service Name	Evaluate statistics on the number of teachers and of students at school	
Brief description of the service	Collect statistical data and informations on the students and on the teachers and extract reports out of that.	
Input from the customer	***Output from the public agency***	
- Data from the ward education officers, which on their part collect data directly from the schools - Monthly reports from the schools - Data of last year - Available budget	- Each April the data will be reported to the Ministy of Education and Culture in the Statistical Deptartment - Reccomendation based on school reports and budget (e.g. needed buildings, needed trining for teachers, scholarhips, hiring of new teachers…)	
Who are the customers of the service?	Members of the public, NGOs and public agencies	
How many customers currently use this service?	Different public agencies, twice a year	
Is it necessary to stick to the written form?	No	
Does the technical manager exercise any judgement?	Yes	
Are any other internal services necessary?	ICT Department, Finance Department, Construction Department	
Are any other external services necessary?	Ministry of Education and Culture	
How should the service be implemented in the electronic form?		
Education Management Information System		
Are any parts of the service already provided in electronic form?		
Ilala municipal database, tables related to education		
Which additional parts of the service could also be implemented in electronic form?		
Website with informations related to school results		
What would be the main objective to develop this service in electronic form?		
To ease up the work, increase efficiency and reliability		
What are the main advantages that you expect from the implementation?		
Fast and reliable statistics		
Any problem expected if the service is provided electronically?	Only at the beginning for the lack of computer equipment	

5.D Assessment of the Information Collected by the Ministry of Education and Culture (MOEC)

During the recent years, MOEC devolved great efforts in collecting education data. Since 1985 it publishes Basic Statistics in Education on a yearly basis. A number of education data is being collected from schools using various methods such as mail questionnaires, documentary, interviews, telephone and fax/e-mail when necessary. Data processing is done electronically on the central level using COBOL Software. On the school, ward, council and regional levels it is done manually.

Other governmental organisations, such as Tanzanian National Examination Council (NECTA), Teacher Service Department (TSD), President's Office Public Service Management (PSM), Ministry of Health (MOH), Ministry of Finance (MOF), National Bureau of Statistics (NBS) and President's Office Regional Administration and Local Government (PORALG) collect education data for their needs without coordinating or linking reciprocally.

Main problems of the current situation in the information on educational data:

- The collected information overlaps in many points
- Redundant efforts and wastage of money, time and resources in the data collection
- The same identical indicator is recorded in different databases, often with different values.
- The data is inconsistent and unreliable
- The information is very scattered: data is inaccessible or data retrieval is extremely time consuming

- As a result of inefficient data retrieval and unreliable information, even the reaction to certain indicators are initiated with delay making MOEC unresponsive to the current situation

5.A2.5 CLASSIFICATION AND EVALUATION OF ONLINE-CAPABLE SERVICES

Since the activity “Selection and exclusion of online-capable services” had been anticipated, the classification and evaluation had implicitly been carried on by the Heads of Department, who proposed the most urgent service to be implemented in the electronic form.

5.A2.6 IDENTIFICATION OF ONLINE-CAPABLE SERVICES

The following have been identified as the most important online-capable services for the District ED:

- Registration of schools
- Modification of data of existing schools
- Registration of pupils
- Management of teacher information
- Management of school facilities, supplies, purchasing
- Financial management of the schools
- Reports on exam results
- Reports on statistical data on the students

5.A2.7 PRESENTATION OF RESULTS OF DATA COLLECTION

The presentation of the results of the data collected is this publication.

5.A2.8 DETERMINATION OF REQUIREMENTS FOR ONLINE-SERVICES

The focal functions of EMIS are the collection, processing, utilizing and dissemination of educational data and information to make it available to educational stakeholders on a timely, routine, reliable and predictable basis via uncomplicated and user friendly interfaces.

The requirements for EMIS have been identified to be the following:

- EMIS should be a comprehensive user and data dissemination oriented system.
- Must be user friendly
- Built-in enforcement of data quality standards and practices needs to be developed (validity and accuracy checks)
- The data forms and data entry sheets should have the similar layout. The data forms will take stock of the data forms which are currently being used by EMIS unit in MOEC.
- Data entry sheets should be simple

- After data is put into the system, the system can automatically process the raw data into education indicators. Configurable report functions should be built in.
- Technology based on Structured Query Language (SQL)
- Compatibility with databases in use by other governmental organisations must be assured
- Archived documents such as information material, research papers, regulations, MOEC policies, Education Act, and other important documents should be linked to EMIS
- Usage of a customised web based data entry systems

5.A2.8.1 Data Entry System Requirements

A customised web based data entry systems based upon EMIS data structure is required.

The principal features of such a system include:

- User friendly data entry using a web browser either on a local intranet or over the Internet.
- Customised tool for data import from widespread office software as Excel, Access or other.
- Compatibility with a wide range of data-sources and back-end databases
- Ease of Navigation: use of metadata to browse through the EMIS, easily navigating with business terminology and not technical phrases.

5.A2.8.3 Performance Requirements

- The system must be available 24 hours a day, seven days a week.

- In order to be fully interactive, the system will have to be able to handle queries and display a message on the screen within a maximum of 15 seconds.
- In case of failure, a system downtime of one working day is the maximum acceptable
- The system should allow multi-users modus, the record being actualised should be locked for exclusive usage by the user which is currently performing the data modification.

5.A2.8.2.1 Information Flow Requirement for primary schools[21]

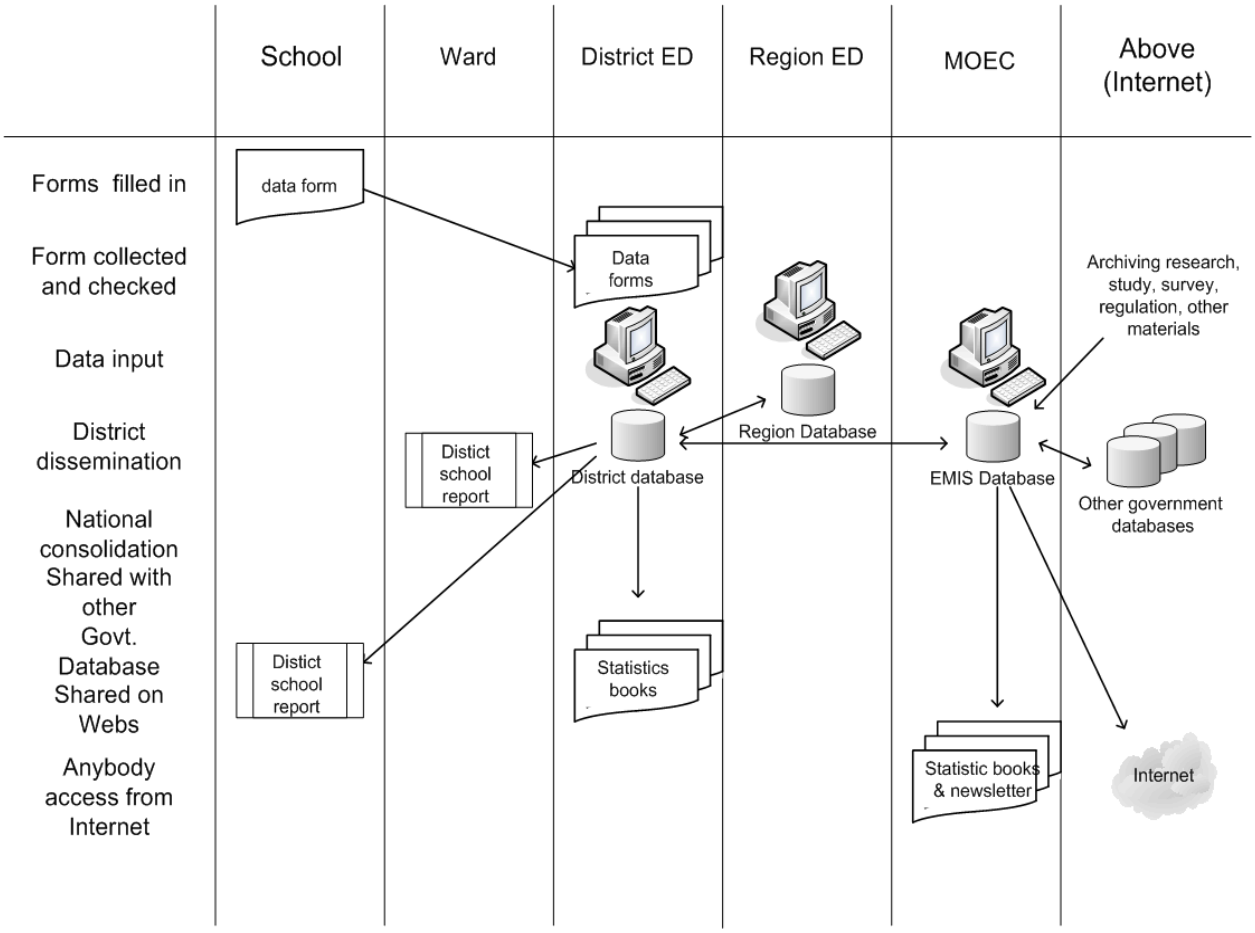

Figure 14: Information flow requirements for primary schools

[21] **MOEC**, *EMIS Development Plan 2005 -2008 – Education Sector Development Programme – Information and Communication Technology (ICT)*. January 2005

5.A2.8.2.2 Information Flow Requirement for secondary schools and colleges[22]

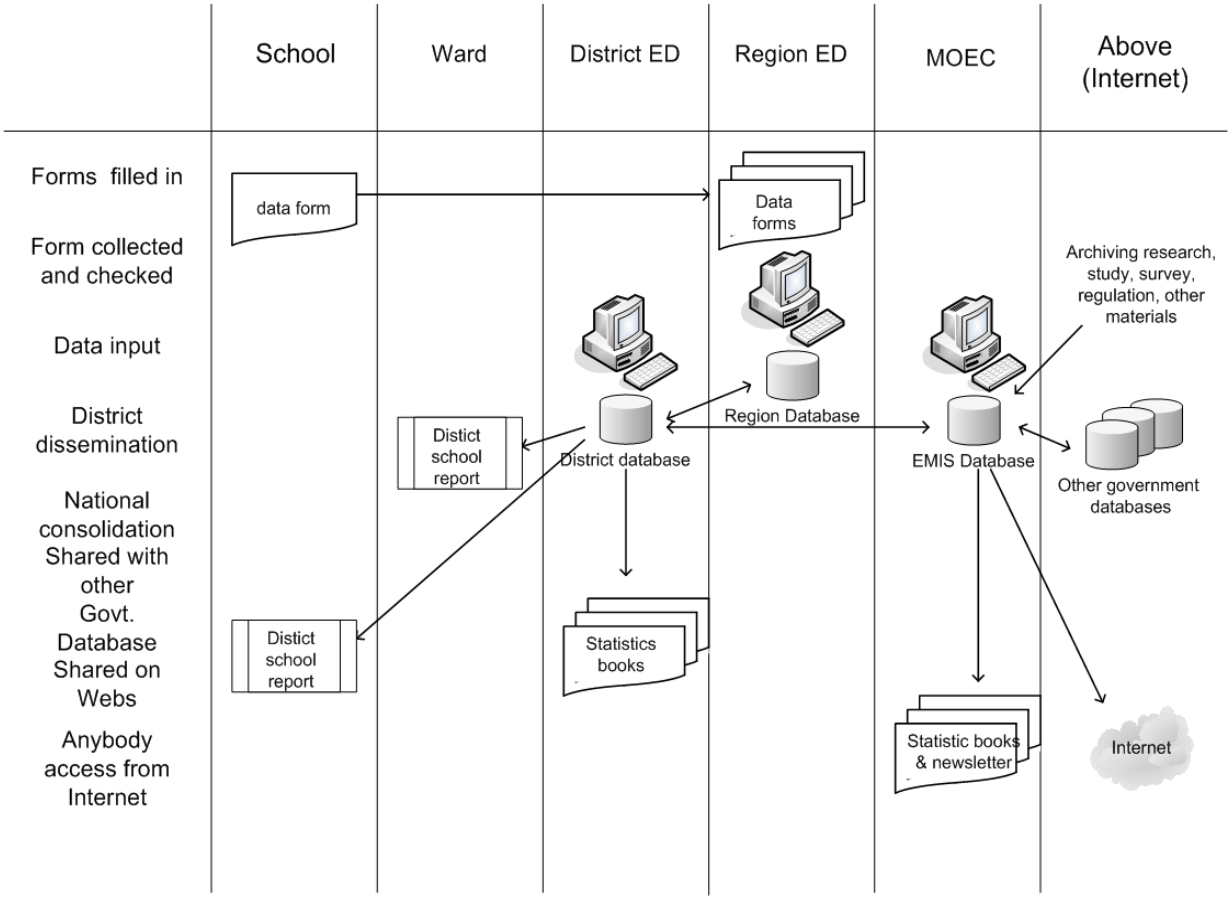

Figure 15: Data information flow requirements for secondary schools

5.A2.8.4 Security Requirements

See activity 3.5

[22] **MOEC**, *EMIS Development Plan 2005 -2008 – Education Sector Development Programme – Information and Communication Technology (ICT)*. January 2005

5.A2.8.5 Functional Requirements

- **Queries capabilities**
    - Easy Query Definition. Make it easy to translate the business need into the proper query.
    - Query Recasting. Even simple-looking queries can result in intensive data retrieval and manipulation.
    - Query Execution. Provide ability for the user to submit the query for execution without any intervention.
    - Results Presentation. Present results of the query in a variety of ways.
    - Aggregate Awareness. Query processing mechanisms must be aware of aggregate tables, whenever necessary, redirect the queries to the aggregate tables for faster retrieval.
    - Query Governance. Monitor and intercept runaway queries before they bring down the data operations.
- **Reports capabilities**
    - Set of preformatted reports. Provide a library of preformatted reports with clear descriptions of the reports. Make it easy for users to browse through the library and select the reports they need.
    - Parameter-driven predefined report. These give the users more flexibility than the preformatted ones. Users must have the capability to set their own parameters and ask for page breaks and subtotals.
    - Easy-to-use report development. When users need new reports in addition to preformatted or predefined reports, they must be

able to develop their own reports easily with a simple report-writer facility.

5.A2.9 PRELIMINARY PLANNING OF PERSONNEL AND FINANCIAL RESOURCES

Since the e-Government plan was not officially approved, the author could only plan on her own time.

5.A2.10 CREATION AND PUBLICATION OF E-GOVERNMENT GUIDELINES FOR STAFF INFORMATION

This has been postponed till the e-Government project will be officially approved and started

Chapter 6

Results from Phase 3 in the case study

6. RESULTS FROM PHASE 3

Phase 3 requires close co-operation between the Organisational and IT Department. During this phase, the work operations are investigated with a view to their later mapping onto IT procedures.

6.A3.1 SYSTEMATIC RECORDING OF PROCESS INFORMATION

To deal with the requirements of e-government, it is necessary to adopt a process-oriented approach. This requires that there is a description of the workflows which makes it possible to identify weaknesses and the potential for improvements in the conventional procedure as well as possible uses for electronic workflow management.

Following are reported the flowcharts representing the processes for each selected online-capable service in the District ED.

In order to anticipate the activity 3.6 “Design of the e-Government process”, two different colours have been used. The boxes with grey background are suitable to be implemented into the e-Government solution.

6.A3.1.1 Process "Private School Registration" – Primary School[23]

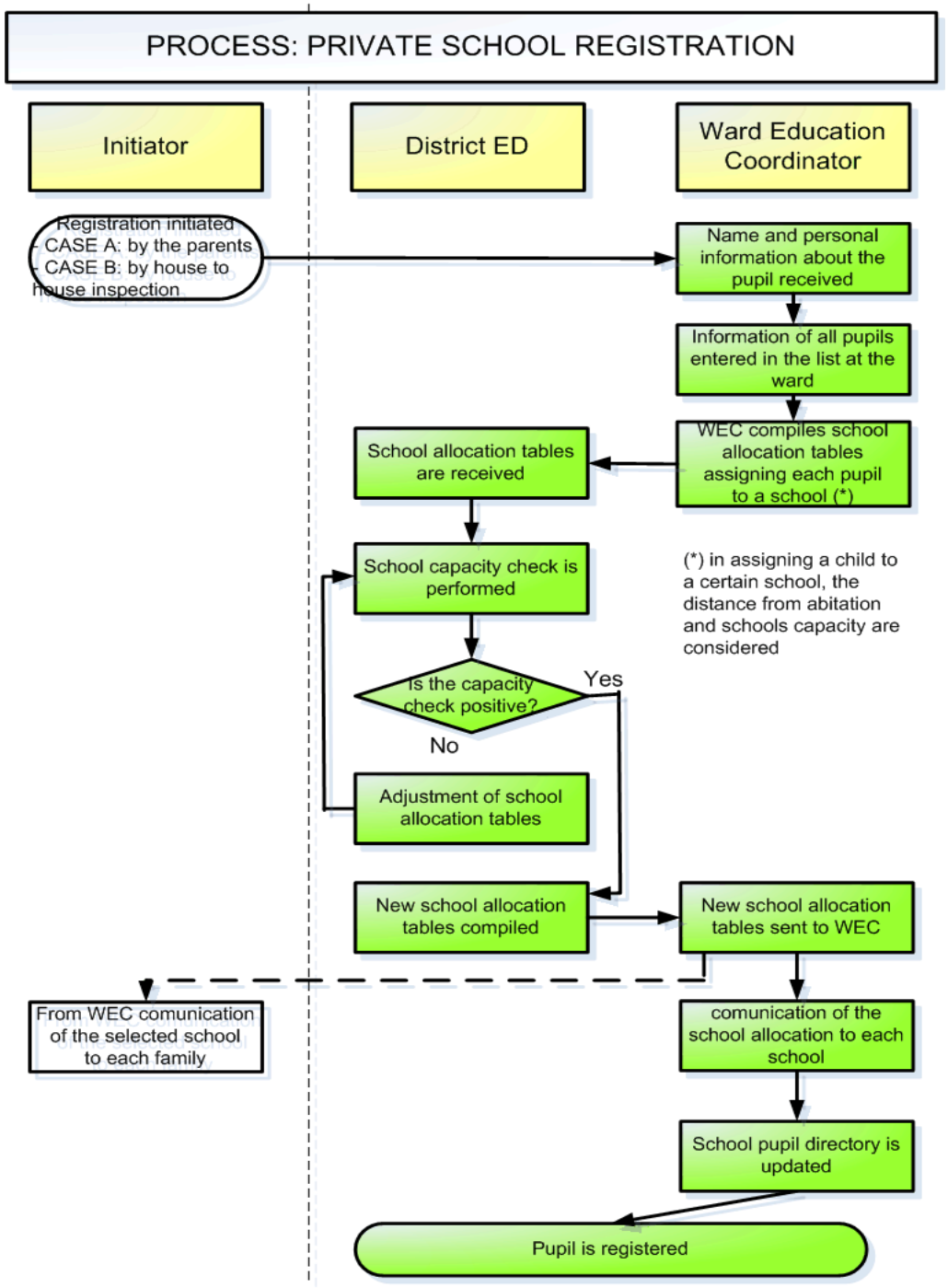

Figure 16: Flowchart of the current process "Private School Registration"

[23] Secondary schools and colleges are reporting directly to the Regional ED, while primary schools are dealt with at the district level

6.A3.1.2 Process “Public School Registration”- Primary School

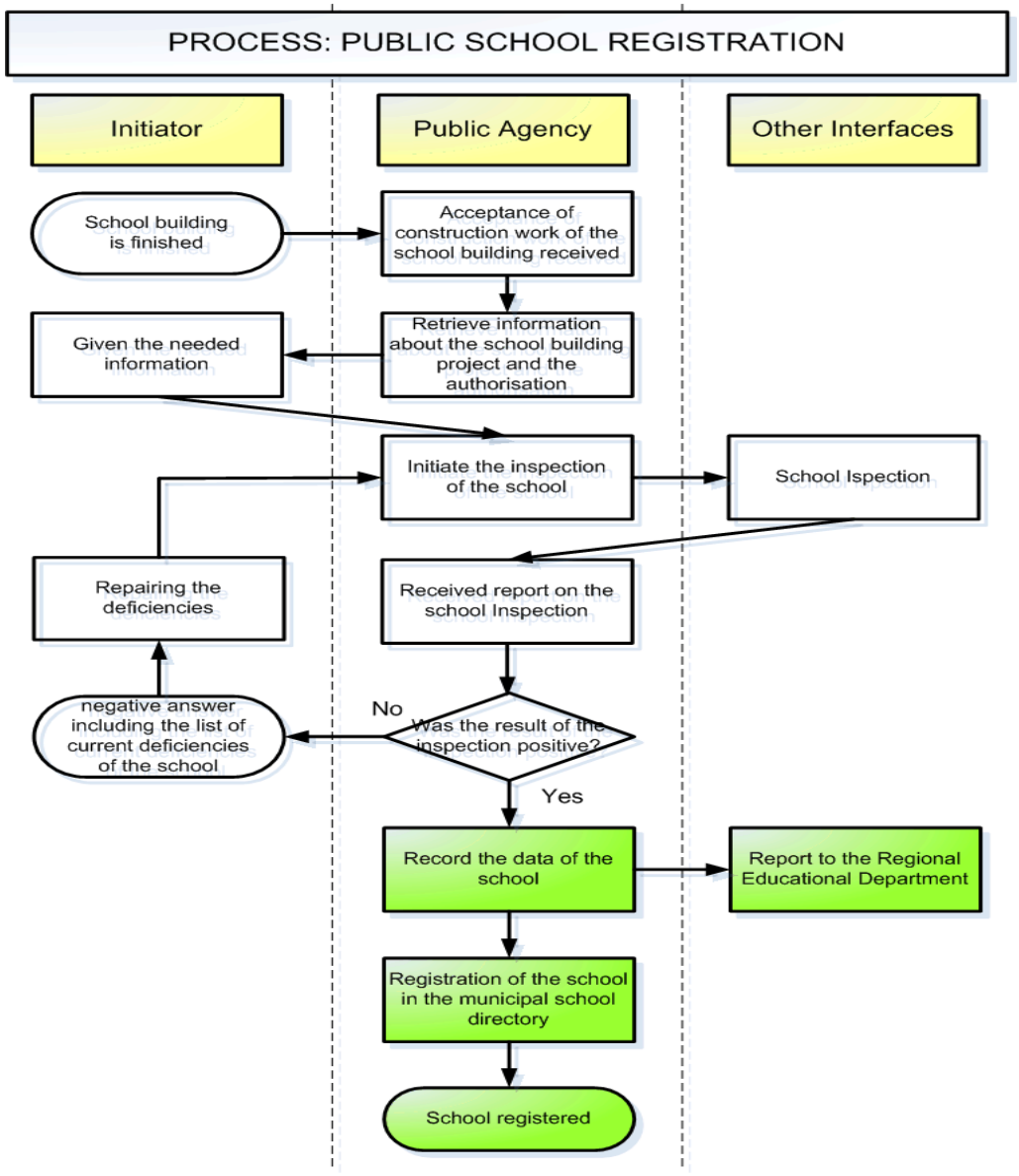

Figure 17: Flowchart of the current process "Public School Registration

6.A3.1.3 Process “Modification of data on an existing school”

- CASE A: Request initiated after the regular bi-yearly inspection
- CASE B: Request initiated by the Head of Teachers
- Modification of the data of the school in the municipal school directory

6.A3.1.4 Process "Registration of Pupils"

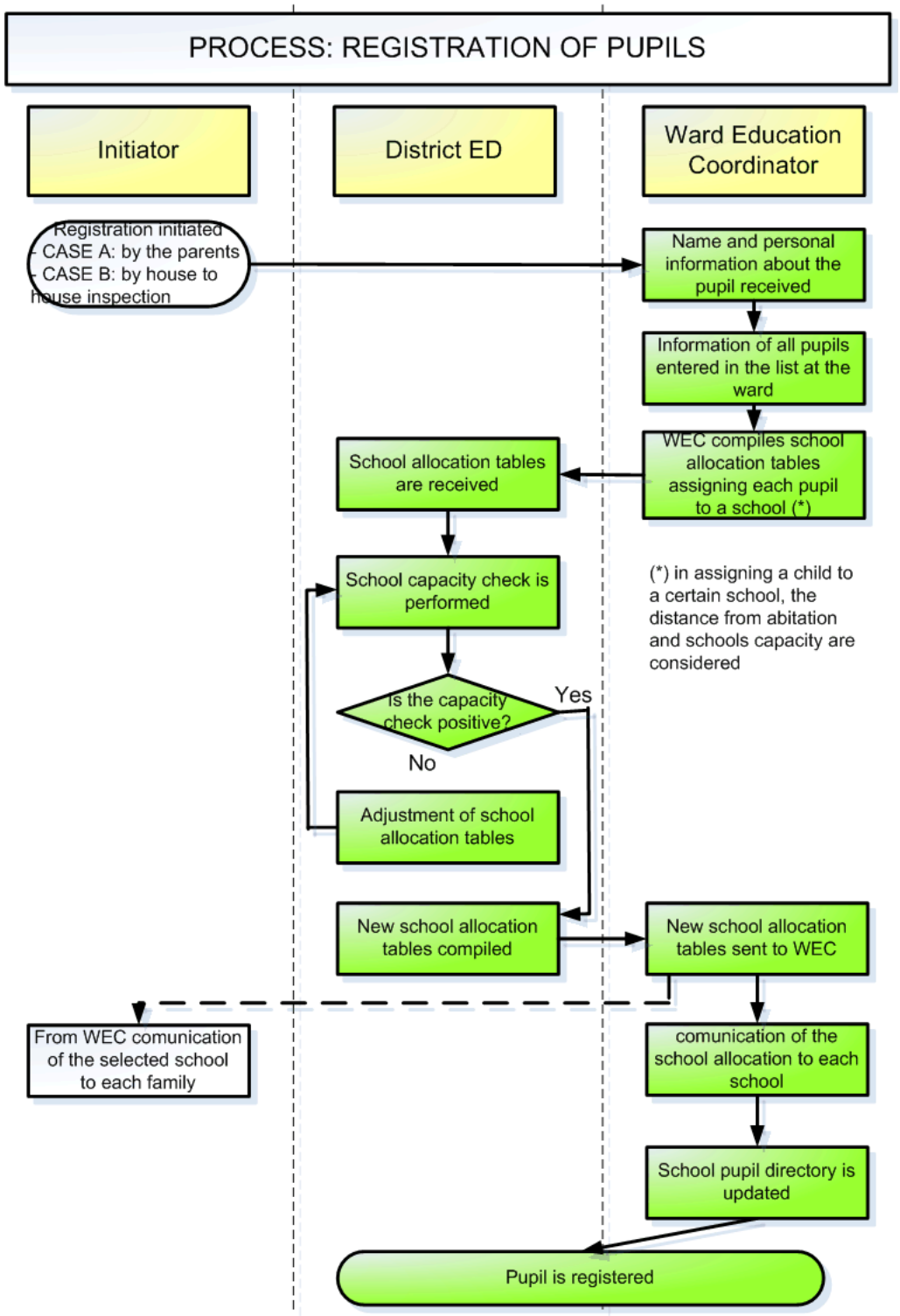

Figure 18: Flowchart of the current process "Registration of Pupils"

7.A3.2.4 Management of teacher information

- CASE A: New teacher

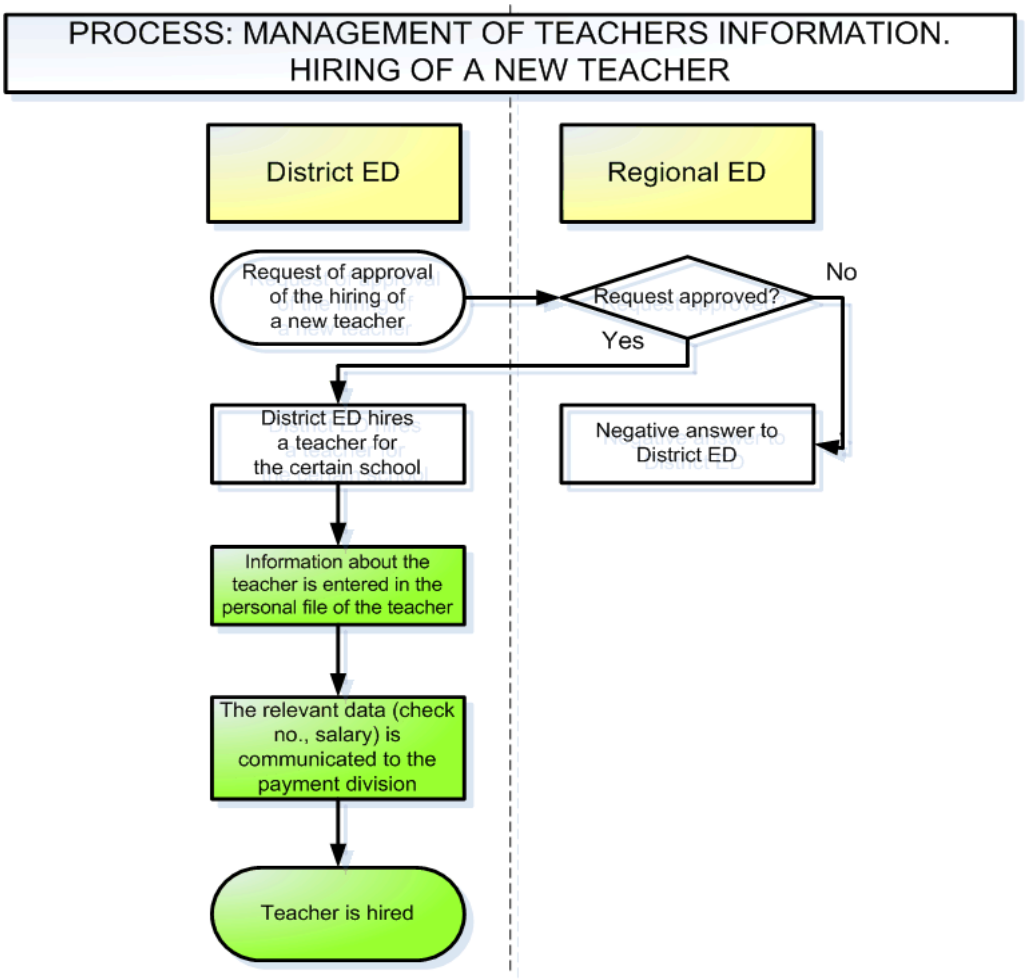

Figure 19: Flowchart of the process "Management of teachers' information" in the case of a new teacher

- CASE B: Modification or termination of an existing teacher
  - CASE BA: change initiated by the Head of Teachers
    - the Head of Teachers informs the District ED the changes
  - CASE BB: change initiated by District ED
    - Request of modification of the teacher's file
    - The changes become recorded in the teachers' file

6.A3.1.5 Management of school facilities, supplies, purchasing

- Valuation of the monthly reports of the schools, comparison between the “due” value of each asset and the “is” value
- Valuation of the budgeted funds
- CASE B: No new asset have to be purchased
    - No action
- CASE A: New asset(s) have to be purchased
    - The supply unity is informed and the order is initiated
    - The Payment Division account for the used sum
    - Accountability is updated
    - Delivery bill for the receiving of supplies is returned to accountancy
    - The new assets are entered into the inventory
    - Update the information about the school

6.A3.1.6 Reports on exam results

- School collects the exam results once a year
- Results are sent to WEC for verification
- WEC sent the verified forms to the District ED.
- District ED officers enter the data in the computer
- Report is sent to MOEC

6.A3.1.7 Reports on statistical data on the students

- Once a month the school presents certain pre-defined reports to the District ED.
- District ED officers enter the data into an excel sheet
- District ED reports twice a year to the MOEC

6.A3.1.8 Reports on school asset needs

- Once a month the school presents certain pre-defined reports to the District ED.
- District ED officers enter the data into an excel sheet
- District ED reports twice a year to the MOEC

6.A3.2 IDENTIFICATION OF PROCESSES THAT ARE CRITICAL TO THE AGENCY

A preselection of the most important online-capable service has already been anticipated in the activity 2.6 to optimise the time available for the e-Government project. As a result only critical processes for the District ED are being analysed in the activity A3.1 “Systematic recording of process information”.

In this activity the priorities at the local level (schools or District ED) and the ones of the MOEC have to be regarded separately.

The main difference is the detail level of the needed information, particularly about the students. Schools need for day–to-day operation detailed information on each pupil (e.g. name, nationality, gender, name of the parents or tutors, address, is he/she disabled? Which disability does he/she has?...), while the ministry needs only once a year general statistical data

(How many non-Tanzanian students per hear? How many students with disabilities? How high was the abandon rate between girl? And boys? …..)

6.A3.3 PROCESS OPTIMISATION

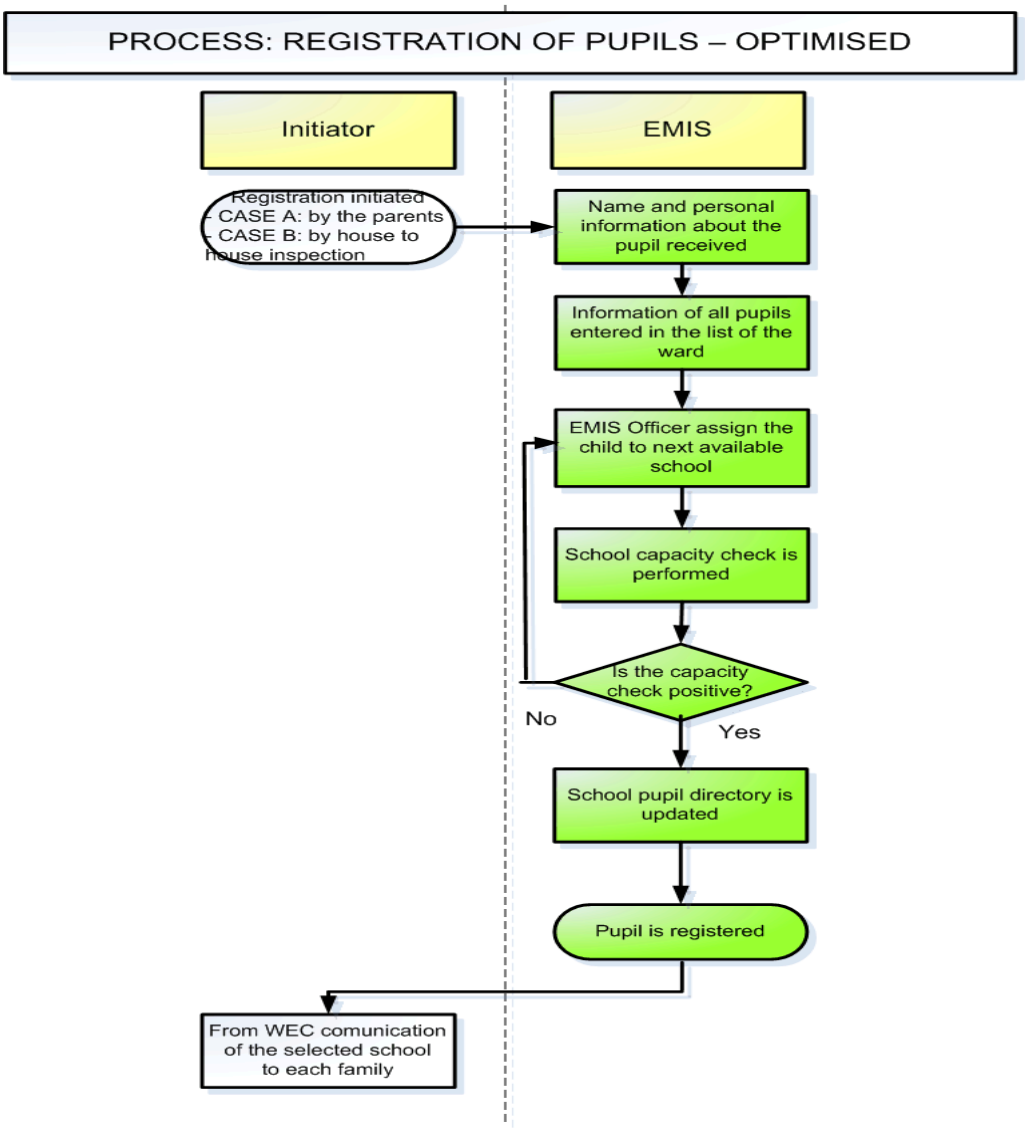

Figure 20: Optimisation of the process "Registration of Pupils" in preparation of the introduction of the e-Government solution

This activity could not be carried out by the e-Government team, which it didn't have the official recognition and a such was not authorised to propose

any structural changes of the public agency an as such has not been performed in detail.

Just as an example the optimisation of the process “Registration of Pupils” in preparation of the e-Government solution has been depicted. Only one entity in the public agency would be responsible for receiving the name of the pupils, assign them to a school, perform the final capacity check and update the school directory. As a result, the current 11 steps would be reduced to 6.

6.A3.4 E-GOVERNMENT-SPECIFIC ASSESSMENT OF PROTECTION REQUIREMENTS

The possible values are: None, Basic, Medium, High and Very High, for which the author used the definition given in the e-Government Manual[24]

Since EMIS operators with the right of changing the data are all employees of the ED and the data is informative and statistical, the aspect leally binding nature is here irrelevant. The written form signed by hand is also not necessary.

Table 11: Assessment of protection requirement

	Value	**Notes**
Confidentiality	None to High	None: information material, research papers, regulations, MOEC policies, Education Act. Basic: Exam results, Medium: Students’ and teachers’ general information as date of birth and marital status High: Teachers’ personal data as check

[24] http://www.bsi.bund.de/english/themes/egov/download/3_Phase3_en.pdf
BSI, e-Government Project Team, *e-Government Manual, Phase 3,* March 2004 page 15

		number and salary grade, school accounting
Integrity	Basic to High	Basic: information material, research papers, regulations, MOEC policies, Education Act. High: All financial aspects Medium: all other information
Authenticity of data	Basic to High	Basic: information material, research papers, regulations, MOEC policies, Education Act. High: All financial aspects Medium: all other information
Authenticity of user	Medium to High	High: For entering and modifying school financial data, and for inserting or modifying teacher's salary data: Medium: All other cases
Availability	High	In case of failure, it is acceptable for EMIS to be out of action up to a maximum of one working day

6.A3.5 DERIVATION OF SECURITY REQUIREMENTS

6.A3.5.1 Confidentiality

None, Basic, Medium: it is desirable but not absolutely necessary to encrypt data.

High: The data categorised "Confidentiality High" is remaining inside the public agency (school administrator, District ED, Regional ED or MOEC) and not transferred to external customers. It is desirable but not absolutely necessary to encrypt data.

6.A3.5.2 Authentication of customer application

Basic: an authentication procedure that plausibly identify the customer is required.

Medium: an authentication procedure in which the user is confirmed by the e-Government solution or by an independent entity

High: All data for which the authenticity of the user is marked as “High” is not exchanged to users outside the public agency, also the usage of qualified electronic signature is not indispensable.

6.A3.6 DESIGN OF THE E-GOVERNMENT PROCESS

In the flowcharts depicted in the activity 3.1. “Systematic recording of process information” the suitability of the old procedures to be implemented in EMIS have been analysed. Suitable tasks have been marked in green colour.

As mentioned in activity A3.2, the requirements of the central government are different from those of the local level. It is important to develop the complete solution first without delaying the delivery of the first working EMIS solution, too.

The recommendation of the author is to plan an Education Management Information System scalable to include all needs. The first implementation, which will be called EMIS1, should be realised as soon as possible. EMIS1 should satisfy all the requirements of the ministry, listed in the document EMIS Development plan[25]. This first EMIS release is the easiest to implement, has the lowest infrastructural requirements and brings advantages immediately.

[25] **MOEC,** EMIS Development Plan 2005 -2008 – Education Sector Development Programme – Information and Communication Technology (ICT). January 2005

Later EMIS1 should be extended to include also the needs of the schools. The roll-out of EMIS1 can be done gradually starting on certain predefined regions.

6.A3.6.1 EMIS1 – System Architecture

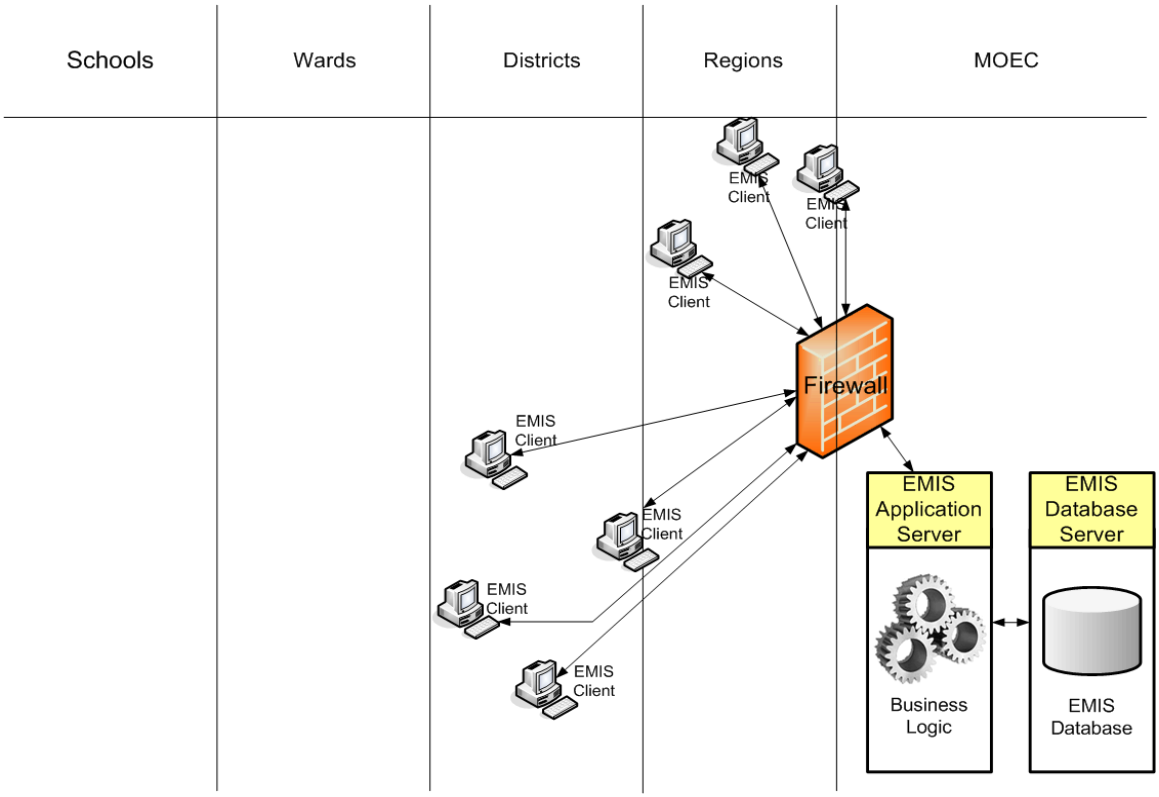

Figure 21: First EMIS release – System Architecture

Figure 21 illustrate the design for EMIS1. The architecture selected is the tier-three. Each district (municipal council) and each regional council will install an EMIS client. The EMIS client will connect to the application server, which will authenticate the user, process the request and collect the data from the database server (DB server). Both the application server as the DB server will be physically located at MOEC and will be protected by a firewall.

The tier-three architecture is strongly recommended since the EMIS clients will be distributed all over the country. Many districts indeed are in remote areas, where there is a lack of ICT trained specialists and insufficient physical connections. The reason of keeping EMIS clients as slim as possible is the only viable solution to assure supportability also in future.

The advantage of a tier-two architecture is that any upgrade, modification or roll-out of the data management or of the business logic has to be done only once centrally for the application server, physically located by the MOEC. Time-consuming installation work for all the numerous EMIS clients located in the remote areas is not needed. In addition this solution is far more secure since the application server itself will control the access to the database.

6.A3.6.2 EMIS2 – System Architecture

The aim for EMIS2, the second release of EMIS, is to extend the system to include also schools. This will be done progressively, starting from certain selected pilot regions, and will be enlarged in a gradual way to include more and more regions. Prerequisite for this kind of extension are the fully implementation of EMIS1 and the availability of a computer which could be used as a client at the school levels. The architecture design is illustrated in figure 22.

The schools in the selected pilot regions will be divided into primary schools and secondary schools/colleges.

Each primary school will be able to enter data into the district database, installed in the District ED (tier-two client server architecture, where the schools are the clients and the computers at the District EDs are the servers)

Each secondary school/college will be able to enter data into the regional database, installed in the Regional ED (tier-two client server architecture, where the schools are the clients and the Regional EDs are the servers).

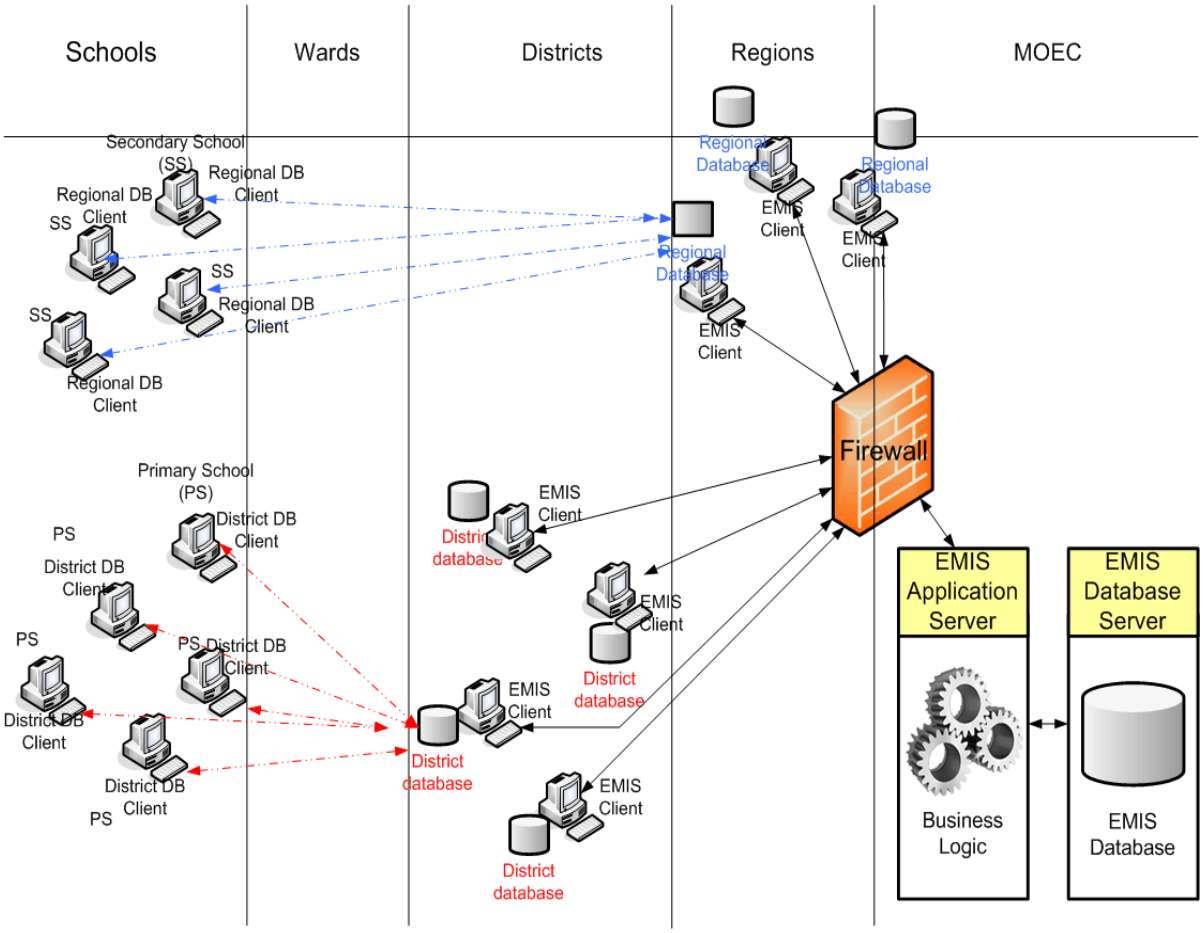

Figure 22: Second EMIS release – System Architecture

Only with this second release, the EMIS clients located in the District EDs and Regional EDs of the selected pilot regions will obtain some business intelligence:

- At the District ED the EMIS clients should be able to extract the relevant data from the district databases (district DBs) automatically and send them to the EMIS application server, which in its turn will update the EMIS database.
- At the Regional ED the EMIS clients should be able to extract the relevant data from the regional databases (regional DBs) automatically and send them to the EMIS application server, which in its turn will update the EMIS database.

6.A3.7 PRELIMINARY CHECK OF LEGAL FRAMEWORK CONDITIONS

EMIS should be a system for the collection, organisation and dissemination of data which will replace the manual data entering and the time consuming reporting system adopted currently. The validation of the users through the integrated security will avoid misuse of the information.

No legal difficulties become evident from the introduction of EMIS.

6.A3.8 REVIEW OF EVALUATIONS FROM PHASE 2 WITH REGARD TO EFFORT REQUIRED AND BENEFITS AND

Since no funds and no personal have been allocated, each result would be worth obtaining it.

6.A3.9 UPDATING OF E-GOVERNMENT STRATEGY

No update of the e-Government strategy is deemed necessary.

Chapter 7

Results from Phase 4 in the case study

7. RESULTS FROM PHASE 4

The high-level design of an information system as EMIS is too detailed to be reported in the frame of this dissertation. For this purpose the author refer to the document EMIS-System Requirements Specification[26] (EMIS SRS) published within this research work. The EMIS SRS intends to be an exhaustive complement of all paragraphs of this chapter.

7.A4.1 SURVEYING THE EXISTING IT LANDSCAPE

The existing IT Landscape at the district level has been surveyed and the results (network plan, summary table of existing IT systems and IT environment) have been reported in chapter 3.

EMIS is meant to serve the needs also of the Regional ED and MOEC. The investigation of the IT Infrastructure of the Regional ED and MOEC however is beyond the scope of this master thesis and was not performed.

7.A4.2 DEFINITION OF THE BASIC COMPONENTS, SERVICES AND STANDARDS TO BE EMPLOYED

7.A4.2.1 <u>The basic components of EMIS1 should be:</u>

- EMIS clients (in the District EDs and in the Regional EDs)

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26 Erika Cammi, *EMIS-System Requirements Specification, Education Management Information System for the United Republic of Tanzania***,** *Version 2*, 2006

- Web server (in the application server located at MOEC)
- Authentication service (in the application server located at MOEC)
- Business logic with query and report capabilities (in the application server located at MOEC)
- EMIS Database server (in the database server, located at MOEC)

7.A4.2.2 <u>The following components should be added in EMIS2, the second release of EMIS:</u>

- Client of the district DB (in primary schools)
- Client of the regional DB (in secondary schools or colleges)
- Authentication service for clients of the district DB (in each District ED)
- District DB (in each District ED)
- Business intelligence to extract data from the District DB and report it into EMIS (in each District ED)
- Authentication service for client s of the district DB (in each District ED)
- Regional DB (in each Regional ED)
- Business intelligence to extract data from the Regional DB and report it into EMIS (in each Regional ED)

7.A4.3 SELECTION OF SUITABLE COMMUNICATION CHANNELS FOR E-GOVERNMENT SERVICES

This activity has been postponed to the time when the e-Government project will be approved.

7.A4.4 CONCRETE DEFINITION OF THE PROTECTIVE MECHANISMS FOR AUTHENTICATION AND ENCRYPTION

The current situation in Tanzania is:

- Urgent need of development of EMIS
- Reduced budget allocated for the EMIS project
- Reduced budget for later ongoing support of ICT systems
- Small availability of ICT highly qualified personal for implementation and later sustainability

In consideration of the above mentioned points, the author does recommend to keep the security concept as easy as possible.

The result of the activity 3.5 “Derivation of security requirements” is that neither encrypted data transmission nor qualified electronic signature are necessary, thus the author strongly dissuades from implementing them for the first version of EMIS.

A system of authentication of the users with username and password will be adequate. Each user should receive certain access level according to his user name. To ease the administration, groups of similar users with certain access levels will have to be created and individual users should be assigned to their groups.

All transactions performed by the users should be recorded in a log file, which will assure the non-repudiation and the traceability of performed changes.

7.A4.5 CREATING THE DATA MODEL

In order to describe relations and dependencies between the data entities of EMIS the author developed an Entity-Relationship Diagram (or ERD). From this diagram it is subsequently relatively easy to derive the concrete database structure. As the name suggests, this model differentiates between entities (objects), i.e. uniquely identifiable elements within a business process that are separate from any other elements, and relations which link these entities. Entities are represented as rectangles, while relations are represented as rhombi. The cardinality of this relations is also reported in the diagram. The entities are assigned attributes which uniquely characterise them. For further details about ERD we refer to Whitten[27]. The detailed list of the attributes of the entities and of the relations is described in the EMIS SRS[28]

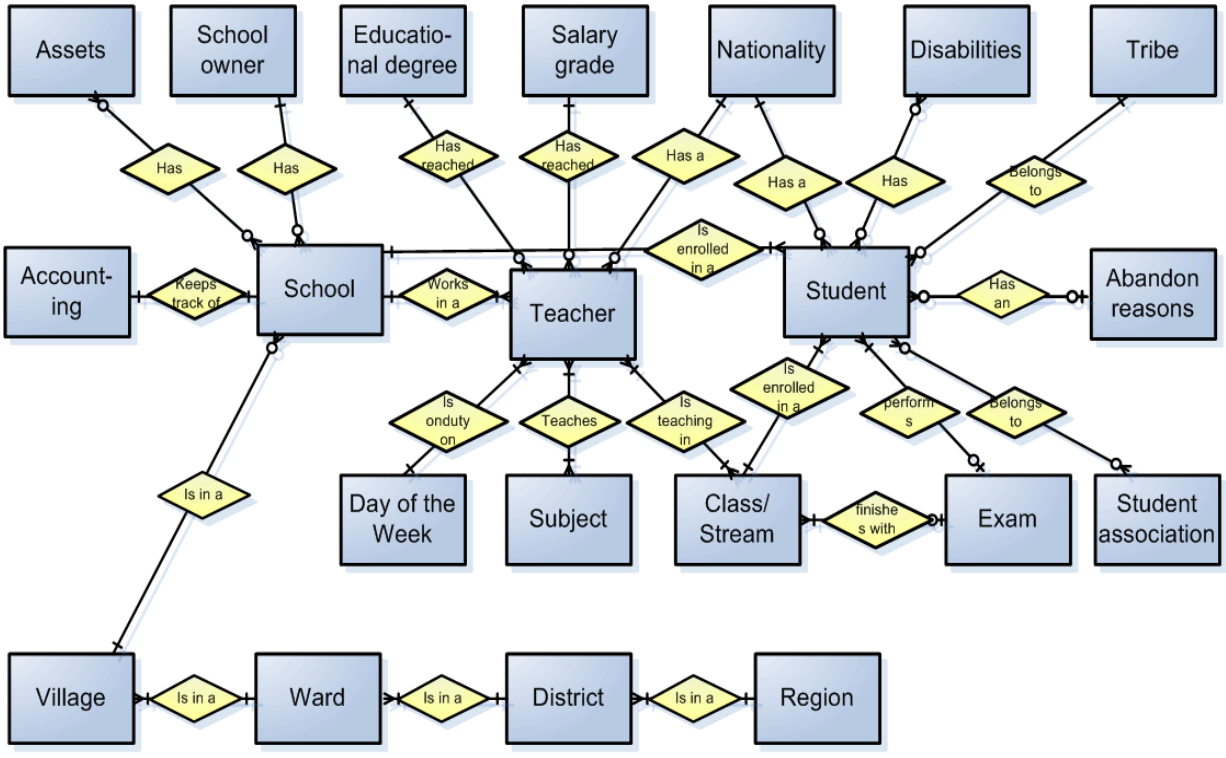

Figure 23: Entity relationship diagram in EMIS

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[27] **Jeffrey L. Whitten, Lonnie D. Bentley, Kevin C. Dittman,** *System Analysis and Design Methods – 5th Edition,* 2001 page 169.

[28] **Erika Cammi**, *EMIS-System Requirements Specification, Education Management Information System for the United Republic of Tanzania, Version 2*, 2006

From the ERD it is easy to obtain a class diagram which depicts EMIS object structure[29]. This diagram shows the object classes of which the system is composed of as well as the relationship between those classes. Additionally to the information available from the ERD Diagram, in the class diagram we can see the following information:

- The abstract class School is the generalisation of the objects Primary school, Secondary school and College.
- Aggregation relationships have been defined between MOEC, the Regional ED and the District ED
- The class Staff has been added, with a non-identifying relationship to the class Role. This will be used to implement the security concept.
- The class Policies has been added, this will make EMIS more suitable also for the usage in the MOEC as tracking and planning tool.
- To incorporate the accountancy at school levels, the class Expenditure has been added.

The EMIS SRS[30] document reports the class diagram including attributes and the methods of the different classes

[29] **Jeffrey L. Whitten, Lonnie D. Bentley, Kevin C. Dittman,** *System Analysis and Design Methods – 5th Edition,* 2001 page 655.

[30] **Erika Cammi**, *EMIS-System Requirements Specification, Education Management Information System for the United Republic of Tanzania, Version 2*, 2006

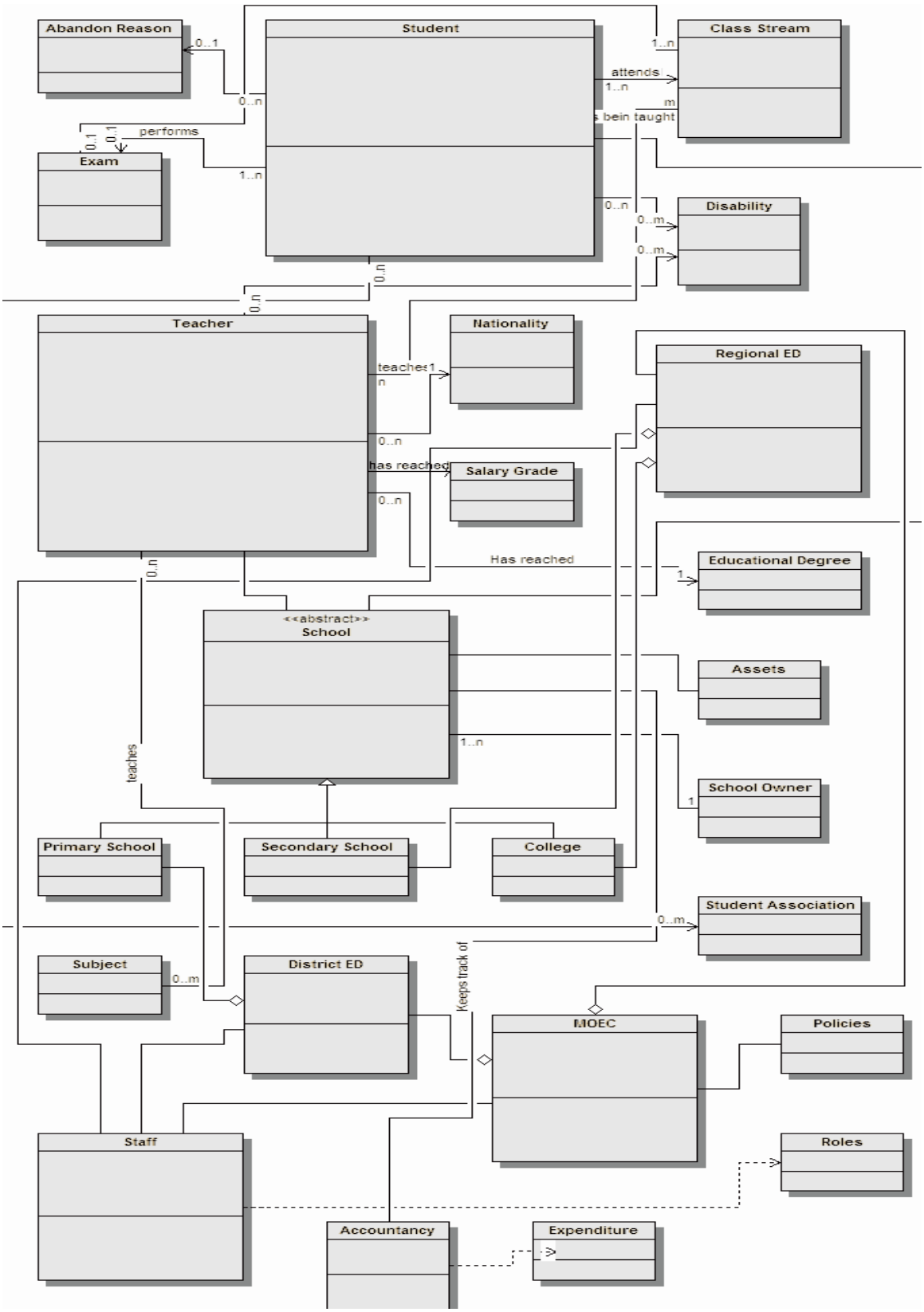

Figure 24: EMIS Class Diagramm

7.A4.6 IT MODELLING OF THE FUNCTIONALITY

7.A4.6.1 Use Case Diagramm

According to the definition given by Whitten[31], the "**Use case modelling** is the process of modelling a system's functions in terms of business events, who initiated the events and how the system responds to an event".

The actors, represented as stylised men, are the ICT administrator of the school, the educational district officer, the regional officer, the MOEC officer and any other.

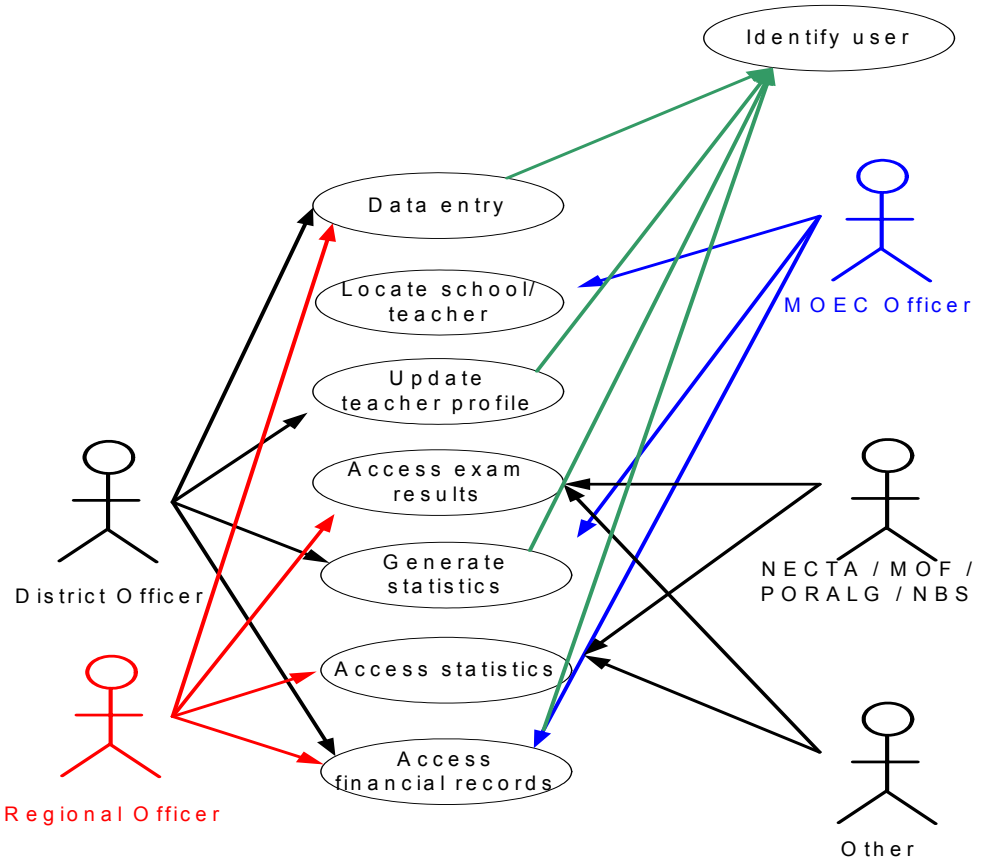

Figure 25: Use Case Diagram: EMIS

[31] **Jeffrey L. Whitten, Lonnie D. Bentley, Kevin C. Dittman,** *System Analysis and Design Methods – 5th Edition,* 2001 page 656

7.A4.6.2 Sequence Diagrams

With the help of **sequence diagrams** it is possible to depict graphically how objects interact with each other via messages. They illustrate in which way and in what sequence messages are sent and received between objects[32]. If one object is communicating with another, a bar is drawn on its time axis. Messages exchanged between the objects and the corresponding responses are indicated by solid or broken arrows. As an example, we take a look on the sequence diagrams for the two tasks “Enter school data” and “Get exam results”, while the complete list of sequence diagrams is available in the EMIS SRS document[33]

7.A4.6.2.1 Sequence diagram for the task “Enter school data”

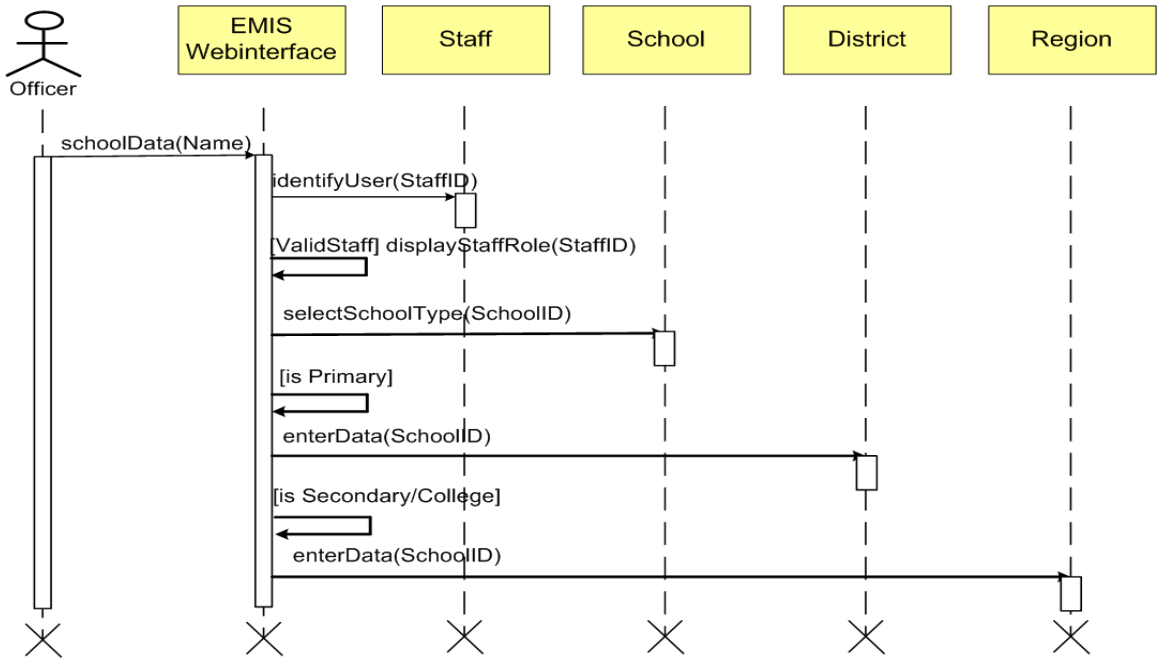

Figure 26: Sequence Diagram for the task “Enter school data”

[32] **Jeffrey L. Whitten, Lonnie D. Bentley, Kevin C. Dittman,** *System Analysis and Design Methods – 5th Edition,* 2001 page 655

7.A4.6.2.2 Sequence diagram for the task "Get exam results"

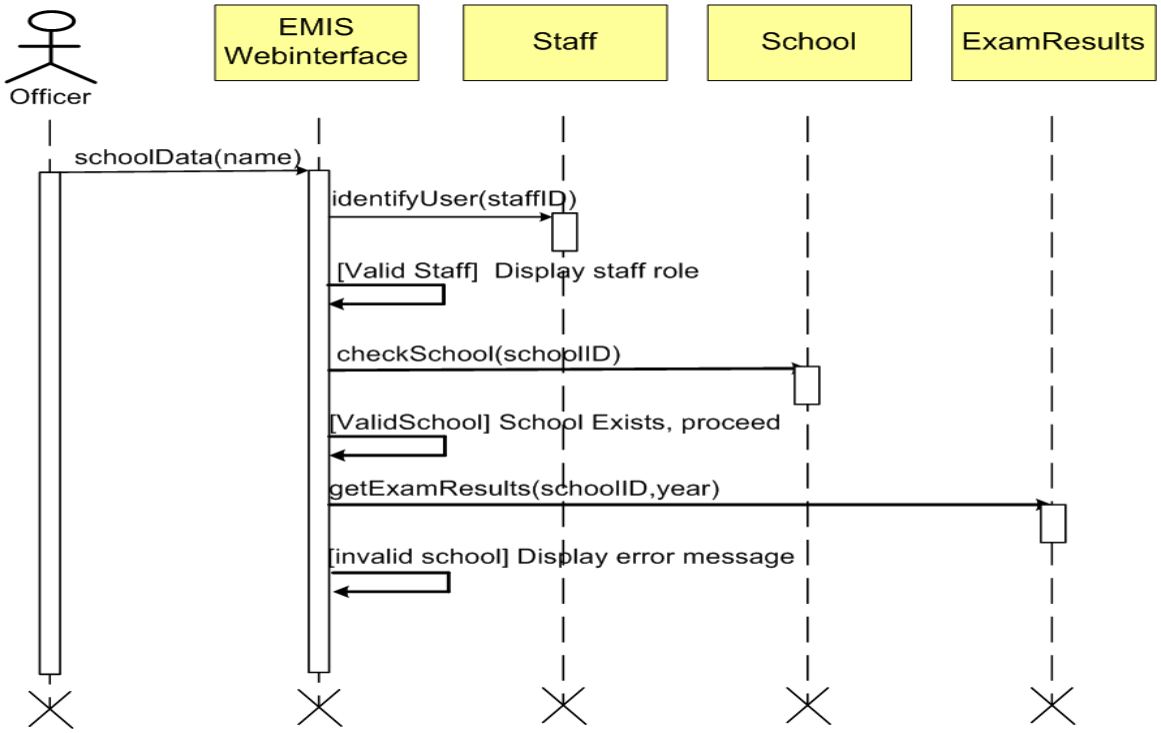

Figure 27: Sequence Diagram for the task "Get exam results"

The EMIS web interface must be able to identify the user through the primary key (StaffID) and retrieve the configured permissions for the specific user. The Web interface will change accordingly and show only the operation that the user is allowed to perform.

7.A4.6.3 Use Cases

According to the definition given by Whitten[35], "a **use case** is a behaviourally related sequence of steps (a scenario), both automated and manual, for the

[35] **Jeffrey L. Whitten, Lonnie D. Bentley, Kevin C. Dittman,** *System Analysis and Design Methods – 5th Edition,* 2001 page 244

purpose of completing a single business task." The author refers to readyset.tigris[36] for the description of the use case format.

The two use cases for the two previous examples (tasks "Enter school data" and "Get exam results") have been reported. For the detailed list of all the use cases of EMIS, the author refers to EMIS SRS[37]

Use Case: Edit school information

USE CASE NAME:	**Edit School Information**
Summary:	The EMIS shall enable the District Officer to enter data for a school.
Priority:	Essential
Use Frequency:	Often
Direct Actors:	Educational District Officer, Regional District Officer
Business Justification	The school information is to be edited when some of the data changes
Precondition	The user must have the right of edit school information or the web interface will not offer him the possibility to edit school information
Main Success Scenario:	1. The user logs in 2. The server identify the user 3. The server retrieves information about the rights of the user 4. The user select the action "modify school information" 5. The web interface is adapted showing only the function allowed to the particular user 6. The user chooses if it is a primary school or a secondary school 7. The list of all recorded school of the selected type is retrieved and displayed 8. The user select between one of the schools 9. The server retrieves and display the data of the school 10. The user modify the data 11. The data is recorded 12. The user logoff
Alternative Scenario Extensions:	• STEP 1.The user is invalid ▪ An error message is displayed ▪ The web interface returns to the login screen

[36] http://readyset.tigris.org/nonav/templates/use-case-format.html#guidelines

[37] **Erika Cammi**, *EMIS-System Requirements Specification, Education Management Information System for the United Republic of Tanzania, Version 2*, 2006

	• STEP 1.The password is invalid ▪ An error message is displayed ▪ The web interface returns to the login screen • STEP 6: The user can find directly the schoolboy entering directly the name of a school or the school ID • The server checks if the school exists in the database • The school exists • STEP 6: The user can find directly the schoolboy entering directly the name of a school or the school ID • The server checks if the school exists in the database • The school does not exist • An error message is displayed • The user will be requested if he wants to create the school. • By positive answer the use case “Create School” will be started • By negative answer the web interface returns at the initial state, after logon • STEP 7 The school which the user wants to modify does not exist ▪ The user can click on “Create a new school” ▪ The Use Case “Create a new school” starts • STEP 10 The data entered for the school is not compliant with the data quality checks enforced into EMIS ▪ An error message is displayed ▪ The data of the school is retrieved again and is displayed
Postconditions	None
Volatility	Medium
Probability of defects	Low
Notes and Questions	None

Use Case: Get exam results

USE CASE NAME:	**Get Exam Results**
Summary:	The EMIS shall enable the District Officer to enter data for a school.
Priority:	Essential
Use Frequency:	Medium
Direct Actors:	Educational District Officer, Regional District Officer, School Admin, School staff, MOEC Officer, Other

Business Justification	Everybody should be able to see the exam results
Precondition	None
Main Success Scenario:	1. The user logs in 2. The server identify the user 3. The server retrieves information about the rights of the user 4. The user enters the name of a school or the school ID 5. The server checks if the school exists in the database 6. The school exists 7. The user type in the year for which he needs the results 8. The user clicks on "Get exams results" 9. The server retrieves the wished exam results and display them 10. The user logs out
Alternative Scenario Extensions:	• STEP 1 The user is invalid ▪ An error message is displayed ▪ The web interface returns to the login screen • STEP 1 The password is invalid ▪ An error message is displayed ▪ The web interface returns to the login screen • STEP4 The user can alternatively navigate to find the school: ▪ The user chooses if it is a primary school or a secondary school ▪ The list of all recorded school of the selected type is retrieved and displayed ▪ The user select between one of the schools • STEP 6 The school desired does not exist ▪ An error message is displayed ▪ The user will be requested if he wants to create the school. ▪ By positive answer the use case “Create School” will be started ▪ By negative answer the web interface returns at the initial state, after logon • STEP 7 For the desired year no data is recorded ▪ An error message is displayed the web interface returns at the initial state, after logon
Postconditions	None
Volatility	High
Probability of defects	Low
Notes and Questions	None

7.A4.7 DEFINITION OF THE ORGANISATIONAL AND TECHNICAL SECURITY SAFEGUARDS

The different users of EMIS have been assigned a role. In addition, domains of competence have been defined: one school, one district, one region.

For this activity the author has defined all the rights that must be assigned to a role - if it has to fulfil its function within the procedure properly - and mapped them into the following table:

Table 12: Representation of a role concept to define the organisational and technical security safeguards

	ICT Admins of the school	District Education Officers	Regional Education Officers	MOEC EMIS Represent.	Other EMIS users
Data set 1: "Exam results"	R	RWD in their district N in others R	RWD in their regions N in others	R	R
Data set 2: "Personal data on Students"	R in their school N in others	RWD for PS in their district N in others	R for SS in their region N in others	R	N
Data set 3: "Personal data on Teachers"	R in their school N in others	RWD for PS in their district N in others	R for SS in their region N in others	R	N
Data set 4: "School registration"	R	RWD for PS in their district R in others	RWD for SS in their region R in others	R	R
Data set 5: "School Budgeting"	R in their school N in others	RWD for PS in their district N in others	RWD for SS in their region N in others	R	N
Data set 6: "Needed Equipment"	R in their school N in others	RWD for PS in their district N in others	R	R	N
Action 1: "User administration" 1.1. School level	N	E for PS in their district N in others	N	N	N
Action 1: "User administration" 1.2. District level	N	E for PS in their district N in others	N	N	N

Action 1: "User administration" 1.3. Regional level	N	N	E for SS in their region N in others	N	N
Action 1: "User administration" 1.4. Ministry level	N	N	N	E	N
Action 2: "Report on students and results"	N	E for PS in their district N in others	E for SS in their region N in others	E	N
Action 3: "Report on needs of the school"	N	E for PS in their district N in others	E for SS in their region N in others	E	N
Action 4: "Report on financial aspects"	N	E for PS in their district N in others	E for SS in their region N in others	E	N

Symbols R: read / W: Write / D: Delete / N: No access / E: Execute

PS: Primary School, SS: Secondary school or college

The cells with the orange background are included into the security and safeguard concept but they will be relevant only in the second release of EMIS. Indeed only in the second release also the ICT operators of the school will be assigned user accounts in the EMIS system. School operators have read only rights and limited to their own schools.

7.A4.8 RESTRUCTURING THE IT LANDSCAPE

Since the detailed analysis of the ICT infrastructure at the ministry and at the Regional ED was out of scope, for this research it is not possible to perform any restructuring.

Assuming that no of the existing ICT facilities at the MOEC could be used to serve for the EMIS project, the author describes the minimal hardware characteristics and the recommended configuration for the following ICT systems:

- DB server located at MOEC
- Application server, located at MOEC
- EMIS clients located both at the District EDs as at the Regional EDs for EMIS1, the first EMIS release
- Recommended hardware upgrades for the EMIS clients needed for EMIS2, the second EMIS release

7.A4.8.1 Hardware recommendations for the database server, located at MOEC

Table 13: Hardware recommendations for the database server, minimum and recommended configuration

	Minimum	**Recommended**
Processor	Intel Pentium III	Pentium IV, Celeron or above
Single/Multiprocesor	Single processor	Double Processor
Clock	1,3 GHz	2,4 GHz or above
Memory	1 GB	2 GB or above
Disk controller	Ultra SCSI	Ultra SCSI or Smart Aray
Hard Disk	5 x 72.8 GB	5x146.8 GB or more
RAID Level	RAID 5	RAID 5
Communication	Ethernet 10/100MBs , Full Duplex, Auto configurable	2x Ethernet 10/100MBs , Full Duplex, Auto configurable
Multimedia Drive	CD Rom 8x	CD Rom RW
Operating System	Windows Server 2003	Windows Server 2003
Power supply	230-240 V	230-240 V
UPS	Yes	Yes
Backup Device	Yes	Yes

7.A4.8.2 Hardware recommendations for the application server, located at MOEC

Table 14: Hardware recommendations for the application server, minimum and recommended configuration

	Minimum	Recommended
Processor	Intel Pentium III	Pentium IV, Celeron or above
Single/Multiprocesor	Single processor	Double Processor
Clock	1,3 GHz	2,4 GHz or above
Memory	2 GB	2 GB or above
Disk controller	Ultra SCSI	Ultra SCSI or Smart Aray
Hard Disk	2 x 72.8 GB	4x72.8 GB or more
RAID Level	RAID 10	RAID 5
Communication	Ethernet 10/100MBs , Full Duplex, Auto configurable	2x Ethernet 10/100MBs , Full Duplex, Auto configurable
Multimedia Drive	CD Rom 8x	CD Rom RW
Operating System	Windows Server 2003	Windows Server 2003
Power supply	230-240 V	230-240 V
UPS	Yes	Yes
Backup Device	Yes	Yes

7.A4.8.3 Hardware recommendations for the EMIS clients located both at the District EDs as at the Regional EDs – EMIS1

Table 15: Hardware requirements for clients in District ED and Regional ED, minimum and recommended configuration – EMIS1

	Minimum	Recommended
Processor	Intel Pentium III	Pentium IV, Celeron or above
Single/Multiprocesor	Single processor	Single Processor
Clock	600 MHz	1 GHz or above
Memory	540 MB scalable to at least 1GB	1 GB or above
Disk controller	Internal controller	SCSI controller
Hard Disk	1 x 36,8 GB Scalable to 5x72.8 GB	5x 72.8 GB or more
RAID Level	RAID 0	RAID 1 or RAID 5
Communication	Ethernet 10/100MBs , Full Duplex, Auto configurable	2x Ethernet 10/100MBs , Full Duplex, Auto configurable
Multimedia Drive	CD Rom 8x RW	DVD Rom RW
Operating System	Windows XP Professional	Windows XP Professional
Power supply	230-240 V	230-240 V
UPS	-	Yes
Backup Device	-	Yes

In the first EMIS release, the EMIS clients at the district and regional level are slim clients, so they don't have very high hardware requirements. Though in consideration of the future extension of EMIS1 to EMIS2, it is important to plan with scalable systems.

7.A4.8.4 Hardware recommendations for the EMIS clients located both at the District EDs as at the Regional EDs – EMIS2

Table 16: Hardware requirements for clients in District ED and Regional ED, minimum and recommended configuration – EMIS2

	Minimum	**Recommended**
Processor	Intel Pentium III	Pentium IV, Celeron or above
Single/Multiprocesor	Single processor	Single Processor
Clock	1 GHz	1 GHz or above
Memory	1GB	2 GB or above
Disk controller	SCSI controller	SCSI controller
Hard Disk	5x72.8 GB	5x 72.8 GB or more
RAID Level	RAID 5	RAID 1 or RAID 5
Communication	Ethernet 10/100MBs , Full Duplex, Auto configurable	2x Ethernet 10/100MBs , Full Duplex, Auto configurable
Multimedia Drive	CD Rom 8x RW	DVD Rom RW
Operating System	Windows XP Professional	Windows XP Professional
Power supply	230-240 V	230-240 V
UPS	Yes	Yes
Backup Device	Yes	Yes